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INCORPORATION BY REFERENCE

U. S. Patent Application Serial No. 09/365,726, filed August 3, 1999, in the name of Richard Edson, entitled "Multi-Service In-Home Network With An Open Interface" and assigned to the assignee of this application, incorporated by reference.

U. S. Provisional Patent Application Serial No. 60/193,813, filed March 31, 2000, in the name of Theodore F. Tabloski, et al., entitled "Home Area Network" and assigned to the assignee of this application, incorporated by reference.

FIELD OF THE INVENTION

The invention relates generally to the field of user-premises or home area networking, to allow different types of systems and/or communications devices to utilize one in-home network to communicate with each other and to access a number of external communication services, and more specifically to systems and methods of providing audio programming information from a plurality of sources to radio receivers over local radio broadcast.

BACKGROUND OF THE INVENTION

U. S. Patent Application Serial No. 09/365,726, filed August 3, 1999, in the name of Richard Edson, entitled "Multi-Service In-Home Network With An Open Interface" (hereinafter "the Edson application") and U. S. Provisional Patent Application Serial No. 60/193,813, filed March 31, 2000, in the name of Theodore F. Tabloski, et al., entitled "Home Area Network" (hereinafter "the Tabloski, et al., application") describe various embodiments of an in-home network and server therefor that provides a number of services. Generally, one of the services is to distribute audio program information to, for example, conventional radio receivers for playing thereby.

SUMMARY OF THE INVENTION

The invention provides a new and improved system for and method of providing, in connection with a home area network that includes a home server, audio programming information to conventional radio receivers that are local to the home containing the home area network.

In brief summary, the invention provides an audio program distribution arrangement for use in connection with a server in a home area network, the audio program distribution arrangement being configured to distribute audio programming over a local audio link. The audio program distribution arrangement comprises an audio programming information receiver module, an audio programming information assembler module and a control module. The audio programming information receiver module is configured to receive audio programming information from a plurality of sources. The audio programming information assembler module is configured to generate assembled audio programming information by selectively assembling said audio programming information as received by the audio programming information receiver module into a selected set of frequencies for transmission over the local audio link. The control module is configured to control the audio programming information receiver module and the audio programming information assembler module.

In one embodiment, the audio program distribution arrangement includes a broadcast arrangement configured to broadcast the assembled audio programming information over a wireless audio link. The broadcast arrangement comprises a base module and at least one remote module. The base module is configured to receive the assembled audio programming information from the audio programming information assembler module and transmit the assembled audio programming information over a second selected set of frequencies. The at least one remote module is configured to receive the assembled audio programming information over the second selected set of frequencies and to convert the received assembled audio programming information to the first selected set of frequencies for broadcast over the wireless audio link. The first selected set of frequencies comprises frequencies that can be received by conventional broadcast radio receivers, such as

1 frequencies comprising the FM radio band. The second selected set of frequencies comprises
2 frequencies at which the assembled audio programming information can be broadcast at a higher
3 power than is permitted in the FM radio band, such as frequencies proximate 900 MHz.

4 BRIEF DESCRIPTION OF THE DRAWINGS

5 This invention is pointed out with particularity in the appended claims. The above and
6 further advantages of this invention may be better understood by referring to the following
7 description taken in conjunction with the accompanying drawings, in which:

8 FIG. 1 depicts a home area network including an arrangement for providing audio
9 programming information to radio receivers that are local to the home area network, using local
10 generally low-power radio broadcast, constructed in accordance with the invention; and

11 FIG. 2 depicts a functional block diagram of a portion of a home server useful in the home
12 area network depicted in FIG. 1 for providing audio program information over local radio broadcast.

13 DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

14 FIG. 1 depicts a home area network 10 including an arrangement for providing audio
15 programming information to radio receivers that are local to the home area network, using local
16 generally low-power radio broadcast, constructed in accordance with the invention. Generally, the
17 home area network 10 facilitates the connection of a plurality of household appliances, devices,
18 television and radio receivers, telephone sets, and other facilities (generally "devices") 11(1) through
19 11(N) (generally identified by reference numeral 11(n)) to a home server 12 over one or more digital
20 communication links generally identified by reference numeral 13 and one or more analog
21 communication links generally identified by reference numeral 14. The home server 12 can also
22 connect to a number of external connections, including a central office in the public switched
23 telephony network (PSTN) over a PSTN link 23, a network such as the Internet over a network link

1 20, a cable connection (for use in providing cable television, telephony, Internet and other services
2 as will be apparent to those skilled in the art) over cable link 22, a compact disk player over a
3 compact disk link 21, a barcode reader over barcode link 24, a local video source 25, and perhaps
4 other devices (such as devices providing information via satellite and the like, home security devices,
5 and so forth) over other links generally identified by reference numeral 26.

6 As described in, for example, the aforementioned Edson and Tabloski, et al, applications, the
7 devices 11(n) can transfer information among themselves over the respective communication link
8 13, 14 to which they are connected. In addition, the devices 11(n) connected to one communication
9 link 13, 14 can transfer information to devices connected to another communication link 13, 14 and
10 between the devices 11(n) and the PSTN, network, cable, etc., through the server 12; in that
11 operation, if one device 11(n') is connected to an analog communication link 14 and another device
12 11(n'') (n'≠n'') is connected to a digital communication link 13, the server 12 can perform a digital
13 to analog or analog to digital conversion as necessary. In addition, the server 12 operates to store
14 information received from the PSTN, network, cable, and devices 11(n) for later transmission over
15 the PSTN, network, cable, etc., and later transmission to the devices 11(n). The information
16 transferred over communication links 13 is preferably in digital form, as is the information stored
17 on the server. On the other hand, information may be transferred over other connections in digital
18 or analog form as appropriate.

19 The devices 11(n) that can be connected to the home area network 10 can include a number
20 of types of appliances, including but not limited to devices such as personal computers, personal
21 digital assistant (PDA) devices, telephony devices (illustratively device 11(N)), and home
22 entertainment devices such as radio and television receivers, DVD, compact disk, video and audio
23 tape and record players, and the like. In addition, devices 11(n) that can be connected to the home
24 area network can include lighting, heating and cooling, and similar systems, as well as appliances
25 such as stoves and ovens. If a particular device is a "legacy" device, that is, a device that itself does
26 not have an interface that can be connected to a digital communication link 13, that legacy device
27 can be provided with a suitable interface to allow it to be so connected.

1 Generally, the home area network 10 operates to allow information to be stored on the server
2 12, transferred among the devices 11(n), and transferred from or to a number of external sources or
3 destinations, including, for example, sources or destinations over a network such as the Internet or
4 the public switched telephony network (PSTN), cable or satellite television or radio, music sources
5 such as compact disks. The information may comprise any form of information, including, for
6 example, audio information, image and video information, information in text form, control
7 information for, for example, controlling one device from another or from the server 12 in relation
8 to, for example, occurrence of certain events, computer programs, and so forth. The home area
9 network can be used to, for example, transfer audio information from sources to destinations such
10 as the server 12 for storage or to various devices 11(n) for playing. Similarly, the home area network
11 10 can be used to transfer image or video information from sources to destinations such as the server
12 12 for storage or to various devices 11(n) for display. In addition, the home area network 10 can be
13 used to transfer control information to control controllable devices, such as lighting, appliances such
14 as stoves and ovens, heating and cooling systems, alarm systems and the like.

15 The communication links 13 may be in any form, including a hard link such as a wire, optical
16 fiber or other arrangement for transferring electrical, optical or other signals among the appliances.
17 Alternatively or in addition, communication links 13 may comprise wireless links, such as but not
18 limited to infrared links or links provided by signals in other parts of the electro-magnetic spectrum.
19 Communication links 13 may comprise communication links specially provided for the home area
20 network 10, and/or they may include pre-existing links such as telephone lines, wiring provided for,
21 for example, AC power distribution, and the like.

22 Each device 11(n) connected to a digital communication link 13 preferably includes or is
23 provided with an interface (not separately shown) that enables it to transmit information, in the form
24 of message packets to, and/or receive information in the form of message packets from each other
25 and the home server 12 over the respective communication link 13. When a device 11(n) receives
26 message packets containing information, it can use the information as described below.

1 Generally, the server 12 includes a number of components (not separately shown), including
2 components for processing, storing and retrieving data in digital form, and for converting data
3 between digital and analog form. With particular reference to the instant invention, the home area
4 network 10, and, in particular, server 12, provides an arrangement whereby audio program
5 information provided by any of a plurality of sources can be broadcast over a local radio broadcast
6 using low-power transmission for reception by radio receivers local to the home that includes the
7 home area network 10. Sources of audio program information may include, for example, sources
8 of audio information received through the network link 20, the cable link 22, the compact disk link
9 21 and the other links 26. In addition, if the server 12 receives audio information from a local video
10 source over local video link 25, it may also broadcast that audio information. Sources available
11 through the network link 20 and/or the cable link 22 may include sources available over networks
12 such as the Internet, and may include, for example, audio sources that broadcast audio programs over
13 the Internet or through the cable system, as well as audio sources from which individual items can
14 be retrieved, and other audio sources that will be appreciated by those skilled in the art. Sources
15 available through the cable link 22 may also include the audio component of television program
16 information received therethrough. The compact disk link 21 may provide audio information from
17 conventional compact disks DVD's, and the like, and, of the DVD's and other disks that provide
18 program information that has both a video component and an audio component, can also include the
19 audio component of the program information.

20 The home server 12 includes an audio information module 40 to broadcast audio program
21 information to the one or more radio receivers that are located in, for example, the home that
22 includes the home area network 10, using low-power broadcast techniques. In one embodiment, the
23 audio program information provided by the audio information module 40 is in analog form, and,
24 specifically, is in the FM ("frequency modulated") radio band of approximately 88-108MHz
25 (megahertz) that can be received by conventional FM radio receivers.

26 The audio program information provided by audio information module 40 may originate
27 from a number of sources. For example, the audio information module 40 may receive audio
28 program information, from a cable provider, satellite connection or the like over the cable link 22.

1 The audio information module 40 may also receive audio program information over, for example,
2 a network such as the Internet over the network link 20. The audio information module 40 may also
3 receive audio information, along with video information that will not be used in connection with
4 audio information module 40, over local video link 25. The audio information module 40 may also
5 receive audio information over the compact disk link 21.

6 In addition, the audio information module 40 may receive textual information, which it can
7 process, in a manner similar to a voice synthesizer, to convert to spoken audio form which can be
8 used as audio program information for transmission to the radio receivers. For example, the textual
9 information may be in the form of Web pages encoded in HTML form, Emails, or other textual
10 information that may be received over, for example, network link 20. The textual information may
11 also be in the form of digital books which may be received over the network link 20, compact disk
12 link 21, or other links 26. Textual information may also be generated by the server 12 itself, and
13 may include, for example, notifications regarding changes of status of security alarm systems,
14 notifications of incoming telephone calls and notifications of other occurrences as will be apparent
15 to those skilled in the art.

16 The audio information module 40 may also receive other forms of information which it may
17 use as audio programming information to be broadcast to the radio receivers, as will be apparent to
18 those skilled in the art.

19 The audio information module 40 will be described in connection with FIG. 2. Generally,
20 the audio information module 40 includes a plurality of modules, including a base module 41 and
21 one or more remote modules 42. The base module 41 is generally co-located with other elements
22 comprising the server 12, including interfaces to the various links 20, 21, 22, 25 and 26 from which
23 the audio program information is received. The remote modules 42, on the other hand, can be
24 distributed throughout the home area to be covered. Under current United States government
25 (Federal Communications Commission) regulation, the amount of power that can be used in the FM
26 frequency band may be insufficient to permit good reception everywhere in a home, and several
27 remote modules 42 may be distributed throughout the home serviced by the server 12 to facilitate

1 coverage throughout. The base module 41 distributes audio program information to the remote
2 modules 42 in a band in which higher power levels can be used. The remote modules 42 receive the
3 audio program information from the base module 41 and transmit it in the FM frequency band. In
4 one embodiment, the base module distributes the audio program information to the remote module
5 in the 900 MHz band (more specifically, the 902-928 MHz), which, under current regulation, allows
6 for use of sufficient power to facilitate reliable distribution throughout the home serviced by the
7 server 12. In that embodiment, the base module 41 generates one or more FM signals of selected
8 carrier frequency or frequencies in the FM radio band, the number of FM signals depending on the
9 number of audio programs to be broadcast, and modulates the FM signal(s) into the 900 MHz band
10 for transmission to the remote modules 42. The remote modules 42, in turn, modulates the signal(s)
11 in the 900 MHz band back into the FM band for broadcast thereby. Since the FM signal(s) are
12 generated in one location, that is, in the base module 41, only one signal generator will be required
13 for respective audio programs to generate the FM signal therefor.

14 FIG. 2 depicts functional block diagrams of an illustrative base module 41 and remote
15 module 42 useful in the home area network 10 described above in connection with FIG. 1. With
16 reference to FIG. 2, base module 41 includes an audio program information receiver module 50, an
17 FM signal generator 51, an 814 MHz signal generator 52, a mixer 53, a bandpass filter 54, an output
18 amplifier 55 and an antenna 56. The audio program information receiver module 50 receives the
19 audio program information from the various audio program information sources, as described above,
20 and provides one or more of them to the FM signal generator 51. In addition, if the audio program
21 information is in, for example, textual form, the audio program information receiver module 50 can,
22 in a manner similar to a voice synthesizer, generate a voice signal therefrom for provision to the FM
23 signal generator 51. The audio program information source or sources that are selected to provide
24 audio program information to the FM signal generator 51, as well as the particular frequency or
25 frequencies in the FM signal band at which the audio program(s) is (are) to be broadcast may be
26 selected by an operator. Preferably, the frequency of frequencies will be such as to not cause
27 interference with, or be interfered with, FM signals from FM broadcast outlets.

1 The FM signal generator 51, in turn, receives the audio program information from the audio
2 program information receiver module 50 and uses the audio program information to generate one
3 or more FM signals therefrom. Generally, it will be expected that, if multiple audio programs are
4 to be broadcast by the audio information module 40 contemporaneously, each will be broadcast on
5 a separate FM signal, and the FM signal generator 51 can provide an FM signal for each such audio
6 program. One or more of the FM signals generated by the FM signal generator 51 may be monaural
7 if the respective audio program is, for example, monaural. On the other hand, one or more of the FM
8 signals generated by the FM signal generator 51 may be stereophonic, which may be desirable if the
9 respective audio program is stereophonic. It will be appreciated that the FM signal generator 51
10 may, however, generate a monaural FM signal for any audio program that is stereophonic, in which
11 case the FM signal generator 51 can combine the right and left audio channels of the stereophonic
12 audio program before generating the FM signal therefor. Similarly, the FM signal generator 51 may
13 generate a stereophonic FM signal for any audio program that is monaural, in which case the FM
14 signal generator may use the monaural audio program for either the left or right stereophonic
15 channel, or both stereophonic channels. In any case, the FM signal generator 51 provides the FM
16 signals generated thereby to the mixer 53.

17 The mixer 53 receives the FM signal(s) provided by the FM signal generator 51 and an 814
18 MHz signal generated by the 814 MHz signal generator 52 and mixes them to generate signals
19 whose frequencies are the sum and difference of the frequencies of the signals from the FM signal
20 generator 51 and 814 MHz signal generator 52. Accordingly, if the FM signal(s) provided by the
21 FM signal generator 51 are nominally 100 MHz (actually falling into the 88-108 MHz FM frequency
22 band), the mixer 53 will mix the FM signal(s) and the 814 MHz signals to generate signals having
23 a nominal frequency of 900 MHz (actually falling into the 902-922 MHz frequency band) and other
24 signal having a nominal frequency of 700 MHz (actually falling into the 726-706 MHz frequency
25 band). It will be appreciated that the particular frequencies in each of the 700 MHz and 900 MHz
26 frequency band that will be generated by the mixer 53 will depend on the particular frequencies of
27 the signals in the 100 MHz FM band that are provided by the FM signal generator 51. In addition,

1 it will also be appreciated that the signals in the 700 MHz and 900 MHz frequency bands will be
2 frequency modulated signals.

3 The signal or signals generated by the mixer 53 are provided to the bandpass filter 54. The
4 bandpass filter 54 allows signals in the 900 MHz frequency band to pass, and filters out signals in
5 other frequency bands, including signals in the 700 MHz frequency band. Thus, the signal or signals
6 that the bandpass filter 54 provides to the output amplifier 55 is or are the signals in the 900 MHz
7 band. The output amplifier 55, in turn, amplifies the signal(s) provided thereto, and provides the
8 amplified signals to the antenna 56 for transmission.

9 The signals transmitted by the antenna 56 of the base module 41 are received by the remote
10 module or modules 42 that are within range of the base module 41. Each remote module 42 includes
11 a receive antenna 60, an input amplifier 61, an 814 MHz signal generator 62, a mixer 63, a bandpass
12 filter 64, an output amplifier 65 and a transmit antenna 66. The receive antenna receives the 900
13 MHz signal or signals that are transmitted by the base module 41 and provides the signal or signals
14 to the input of input amplifier 61. It will be appreciated that the signal or signals provided by the
15 receive antenna to the input amplifier 61 may include not only the signal(s) transmitted by the base
16 module 41, but also signals of other frequencies that may be received, including signals outside of
17 the 900 MHz frequency band. As will be made clear below, the remote module 42 need not have
18 a tuner or filter to filter out signals that are outside of the 900 MHz frequency band prior to providing
19 the signal(s) to the input amplifier 61.

20 The input amplifier 61 amplifies the signal(s) provided thereto by the receive antenna 60.
21 The input amplifier 61 may be a relatively broadband amplifier, in which case it can amplify signals
22 input thereto in a relatively broad frequency range, which may include signals well outside of the
23 900 MHz frequency band. Alternatively, the input amplifier may be selected so as to amplify
24 primarily signals in the 900 MHz frequency range.

25 The mixer 63 receives the amplified signal(s) provided by the input amplifier 61 and an 814
26 MHz signal generated by the 814 MHz signal generator 62 and mixes them to generate signals
27 whose frequencies are the sum and difference of the frequencies of the signals from the input

1 amplifier 61 and 814 MHz signal generator 62. Accordingly, if the amplified signal(s) provided by
2 the input amplifier 61 in the 100 MHz frequency band (actually falling into the 88-108 MHz FM
3 frequency band), the mixer 63 will mix those amplified signal(s) and the 814 MHz signals to
4 generate signal(s) having a nominal frequency of 100 MHz (actually falling into the 88-108 MHz
5 frequency band) and other signal(s) having a nominal frequency of 1700 MHz (actually falling into
6 the 1702-1722 MHz frequency band). If the amplified signals provided by the input amplifier 61
7 includes signals outside of the 900 MHz frequency band, the mixer 63 will also generate output
8 signals whose frequencies are the sum and difference of the frequencies of those signals and the 814
9 MHz signal provided by the 814 MHz signal generator 62. It will be appreciated that the particular
10 frequencies in each of the 100 MHz and 1700 MHz frequency band that will be generated by the
11 mixer 63 from the signal(s) received from the base module 41 will depend on the particular
12 frequencies in of the signals the 900 MHz FM band that are provided by the base module 41.

13 The signal or signals generated by the mixer 63 are provided to the bandpass filter 64. The
14 bandpass filter 64 allows signals in the FM frequency band, 88-108 MHz to pass, and filters out
15 signals in other frequency bands, including signals in the 1700 MHz frequency band and signals
16 outside of the 900 MHz signal band that might have been received by the remote module 42. Thus,
17 the signal or signals that the bandpass filter 54 provides to the output amplifier 65 is or are the
18 signals in the FM frequency band. The output amplifier 65, in turn, amplifies the signal(s) provided
19 thereto, and provides the amplified signals to the antenna 66 for transmission. Preferably, the output
20 amplifier 65 will amplify the signal such that the signal as transmitted by the antenna 66 will be
21 within the power limitations specified by government regulations, if any.

22 The invention provides a number of advantages. In particular, the invention provides an
23 arrangement for providing a home area network that includes an audio information module that can
24 distribute audio program information received from one or more sources to radio receivers in the
25 home.

26 In addition, by providing a separate base module 41 and one or more remote modules 42, the
27 home area network 10 can achieve good coverage of portions of a home for which FM signal

1 coverage is desired, regardless of where in the home the server 12 is located. For example, if the
2 server is located in the basement of a home and coverage is desired in the second floor, the remote
3 module can be located on the second floor to readily provide the desired coverage.

4 It will be appreciated that a number of changes and modifications may be made to the home
5 area network described above in connection with FIGS. 1 and 2. For example, if the home is of
6 appropriate size, or if the regulatory situation is such that higher power levels can be used in the FM
7 frequency band (88-108 MHz), the use of separate base and remote modules 41 and 42 may not be
8 needed. In that case, the output from the FM generator 51 can be coupled directly to the output
9 amplifier 55 to permit signals in the FM

10 In addition, although the audio information module 40 has been described as making use of
11 the 900 MHz band in connection with transmission between the base module 41 and the remote
12 module(s) 42, it will be appreciated that any convenient unlicensed frequency band can be used in
13 which personal broadcast is permitted.

14 Generally, in the 900 MHz frequency band, under current US federal government regulations
15 it is desired that the signals not remain at the same frequency in the band for more than a selected
16 period of time. In that case, the 814 MHz signal generators 52 and 62 can be "spread spectrum"
17 generators that are enabled to "frequency hop," that is, periodically shift their frequencies, with a
18 period and frequency differential that is known to both generators 52 and 62.

19 Furthermore, it will be appreciated that the base module 41, instead of initially modulating
20 the audio program information onto signals in the 88-108 MHz FM frequency band and then re-
21 modulating them onto signals in the 900 MHz frequency band, can modulate the audio program
22 information directly onto signals in the 900 MHz frequency band. In that case, instead of providing
23 separate FM signal generator 51, 814 MHz signal generator 52, mixer 53, and bandpass filter 54, the
24 base module 41 can be provided with a signal generator capable of generating frequency-modulated
25 signals in the 900 MHz frequency band, or other frequency band if another frequency band is to be
26 used.

1 It will be appreciated that a system in accordance with the invention can be constructed in
2 whole or in part from special purpose hardware or a general purpose computer system, or any
3 combination thereof, any portion of which may be controlled by a suitable program. Any program
4 may in whole or in part comprise part of or be stored on the system in a conventional manner, or it
5 may in whole or in part be provided in to the system over a network or other mechanism for
6 transferring information in a conventional manner. In addition, it will be appreciated that the system
7 may be operated and/or otherwise controlled by means of information provided by an operator using
8 operator input elements (not shown) which may be connected directly to the system or which may
9 transfer the information to the system over a network or other mechanism for transferring
10 information in a conventional manner.

11 The foregoing description has been limited to a specific embodiment of this invention. It will
12 be apparent, however, that various variations and modifications may be made to the invention, with
13 the attainment of some or all of the advantages of the invention. It is the object of the appended
14 claims to cover these and such other variations and modifications as come within the true spirit and
15 scope of the invention.

16 What is claimed as new and desired to be secured by Letters Patent of the United States is: